

ROAD USAGE CHARGING IN THE UNITED STATES

White Paper for the VT Road Usage Charge Implementation Plan

Prepared by CDM Smith

SECTION 1

1.1 Introduction

In the formation of the Advisory Committee, the Vermont Transportation Agency begins a formal process for evaluation of a road usage charge concept for replacing or augmenting fuel taxes not paid for electric vehicle use in the state. Although currently manageable, the revenue loss from electric vehicle use will grow and have significant impact just as Vermont realizes its goals for high levels of electric vehicle adoption.

Though introductory, this paper provides background on some of the most promising new transportation funding mechanisms in the United States. This broad overview will build a common level of understanding for Advisory Committee Members as they seek to address and resolve issues and challenges and make policy decisions for the State's consideration of the feasibility of implementing a road usage charge system. More information on key topics will come later in the form of technical memoranda to aid the Advisory Committee's deliberations.

Sections 2 and 3 introduce the topic of road usage charging by telling the story of the motivation, the investigation and the progress of charging by the mile for funding transportation systems in the United States. These sections discuss research on road usage charging concepts such as mileage-based user fees, annual flat fee and per kilowatt hour fees. Section 4 presents the VTrans concept for applying these new revenue mechanisms for funding Vermont's transportation system. Sections 5 and 6 discuss how these new systems actually collect fees. Section 7 introduces some of the primary issues impeding adoption of these concepts in other states. Section 8 makes some projections for the future of alternative funding in the United States.

Appendices A and B introduce a summary description of the key issues the advisory committee must address in determining recommendations for how, or whether, the Vermont Transportation Agency should go forward with the road usage fee concept.

SECTION 2

2.1 Why consider road usage charges for funding the transportation system?

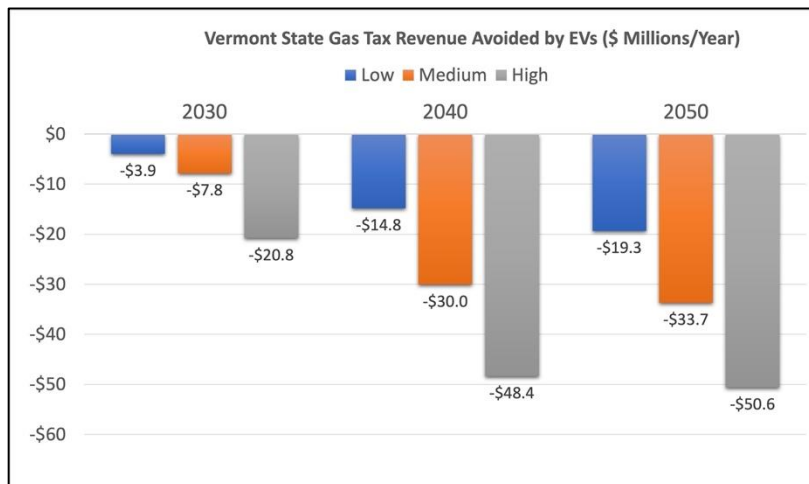
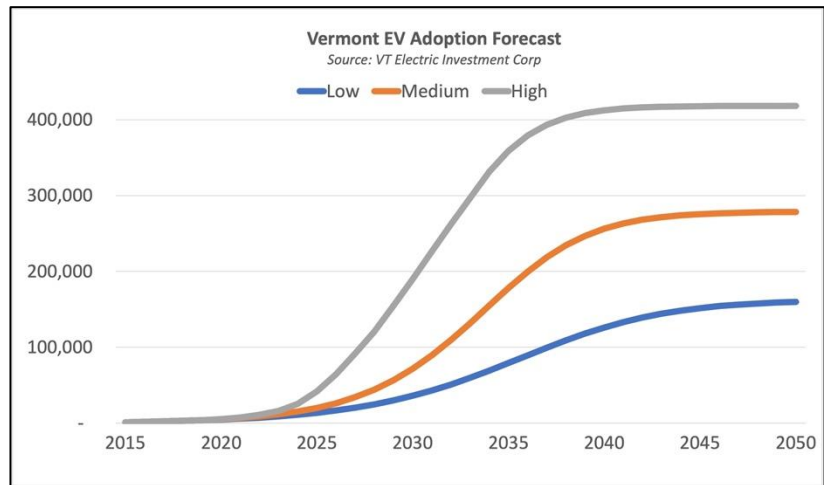
Throughout the 20th century, the excise fuel tax provided the primary means of funding the maintenance and modernization of the nation's roadway system. Across the land, legislatures

periodically increased fuel taxes to expand the roadway system to accommodate population growth and to prevent the erosion of revenues from the effects of inflation.

Based on the *user pays principle*, the legislatures' choice of the excise fuel tax for road funding was an attempt to make the roadway users responsible for roadway upkeep. This strategy worked well for nearly a hundred years.

In the early 21st century, another erosion factor entered the picture: the entry into the marketplace of highly fuel-efficient vehicles which operated using little or no fuel. This new erosion factor could only be allayed by fuel tax increases for a temporary period before the inequity of putting the entire burden of roadway funding needs onto only conventional vehicles

would face strong resistance. To solve this erosion problem, the states would have to create a new method of funding roadways that did not rely upon the purchase of fuel.



The fuel efficiency erosion factor, in particular, undermined the user-pays nature of the fuel excise tax. The amount of fuel taxes the users paid varied widely depending upon the fuel efficiency of the vehicle. By the turning of the 21st century, operators of fuel-inefficient vehicles would pay four or five times the amount of fuel tax per mile as the operators of fuel-efficient vehicles. Indeed,

operators of all-electric vehicles paid no fuel tax at all, although they do pay other fees that contribute to the state transportation fund such as license and registration costs and vehicle purchase and sales taxes.

At the beginning of the 21st century, in an attempt to stabilize the road revenue system, state legislatures explored potential future revenue mechanisms to replace the heretofore robust

fuel tax. Preferring to maintain the user pays principle, state legislatures mainly explored road user charges for replacing or augmenting the excise fuel tax.

SECTION 3

History of road usage charging in the United States

3.1 Mileage-based user fees. For over two decades, the states have investigated and tested the concept of paying per-mile or a flat fee as an alternative to the fuel tax to make up for lost revenue from greater usage of electric and other high mileage vehicles. At least 26 US states have engaged in policy or technical research on distance-based road usage charging (MBUF) for light vehicles,^{1 2} seven of them running formal public pilots,³ five participating in a multi-state coalition's demonstration,⁴ and three enacting operational programs⁵ with two actually running program operations.⁶ These pilot tests and operational programs have revealed functional systems for per-mile fee collection.

In the early years, only four states funded their own research. Once Congress authorized financial support for state investigation of transportation funding alternatives in 2015, many more states rushed to investigate road usage charging at a faster pace.

Heavy vehicle⁷ distance-based charging requires a wholly different system than for light vehicles. An MBUF system for heavy vehicles must account for weight and configuration in addition to distance traveled. While only four US states collect weight-distance taxes⁸ for heavy vehicles, each has done so for many decades.⁹ Several nations apply weight and distance based taxes for heavy vehicles, yet only one nation (New Zealand) applies a very limited mandate for road usage charging for light vehicles. Though fairly new, states have seriously investigated road usage charging for light vehicles over the past two decades.

Following more than a decade of research and pilot testing, the Oregon legislature enacted in 2013 a permanent per-mile road usage charge of 1.5 cents per mile for volunteer motorists of

¹ The term *mileage-based user fee* (MBUF) means charging for distance traveled within a jurisdiction's road network. In some states, distance-based charging is referred to by other terms, such as, per-mile road usage charging (RUC) or Vehicle Miles Tax (VMT) or mileage fee.

² 17 of the states are members of the RUC West coalition (Oregon, California, Washington, Utah, Hawaii, Colorado, Nevada, Wyoming, Idaho, Arizona, New Mexico, Texas, Oklahoma, Montana, North Dakota, Nebraska, Alaska); Six are members of the Eastern Transportation Coalition (Delaware, Pennsylvania, Virginia, New Jersey, North Carolina), and Vermont, Minnesota, Kansas and Ohio.

³ Oregon (2006-07, 2012-12), Minnesota (2006, 2012), California (2016-17), Colorado (2016-17), Washington (2019-20), Hawaii (2019-21).

⁴ Delaware and Pennsylvania (2018 and 2019) and New Jersey, Virginia and North Carolina (2020).

⁵ Oregon (2013), Utah (2018) and Virginia (2020).

⁶ Oregon (2015-ongoing) and Utah (2020-ongoing)

⁷ Commercial trucks, construction vehicles, buses, etc.

⁸ Weight-distance taxes are based on several factors: distance-traveled, vehicle configuration and weight. Per-mile road usage charging is based only on distance traveled.

⁹ Oregon, New Mexico, Kentucky and New York.

light vehicles that became operational in 2015. Branded OReGO, this state legislature mandated this program to provide an offset of the fuel tax paid by the operator of the participating vehicle. Only residents of Oregon were eligible to volunteer for participation in the OReGO program. Motorists not volunteering continue to pay the fuel tax. Having no ability to volunteer for participation in OReGO, nonresident drivers therefore continue to pay the fuel tax while driving in Oregon.

Following Oregon's enactment of an operational per-mile road usage charge, other states continued the investigation along the lines of the OReGO program but with improvements such as expanded options for mileage reporting and systems for interoperability. California tested a pilot program with 5,000 participants and six reporting options in 2016-17. Washington did the same with 2,000 participants and four reporting options in 2018-19. In 2018, Colorado conducted a demonstration as did Pennsylvania and Delaware under the sponsorship of the Eastern Transportation Coalition (ETC). In 2020, the ETC added New Jersey, Virginia and North Carolina to its efforts. Only Washington's pilot engaged out-of-state vehicles, collecting real-money in a financial interoperability test with OReGO and mock-billing tests with residents of Idaho and British Columbia, Canada.

In 2020, Utah launched the nation's second, operational, per-mile fee program (after OReGO). Also in 2020, the Virginia Legislature adopted the third operational, per-mile fee program but has yet to launch its program.

The federal government has engaged in research of road usage charging, but not undertaken any formal testing or pilot program. Congress did create the Surface Transportation System Funding Alternatives (STSFA) grant program in 2015 which has provided numerous states a total of nearly \$74 millions in federal funding for innovative road funding development efforts with per-mile fees as the primary conceptual beneficiary. Prior to the STSFA grants, only four states proceeded with per-mile fee development with only state funding.

The progress on per-mile fee development among the states is not uniform nor does it follow a common process. Those states supported by a legislative directive have stable R&D or actual operational programs while those states without legislative support may stall or shift focus.

State	Per-mile fee legislative authority	Per-mile fee public pilot demo	Operational per-mile fee program	Nature of per-mile fee system	Per-mile fee account management	All Electric Vehicle annual flat fee surcharge
Oregon	2001	2006-07 & 2012-13	2015 to present	Account-based open system	Choice of state or private sector market	\$110
California	2014	2016-17	none	Account-based open system	Choice of state or private sector market	\$110 indexed

State	Per-mile fee legislative authority	Per-mile fee public pilot demo	Operational per-mile fee program	Nature of per-mile fee system	Per-mile fee account management	All Electric Vehicle annual flat fee surcharge
Washington	2012	2018-19	none	Account-based open system	Choice from two private sector providers	\$150
Utah	2018	TBD	2020-21	Account-based open system	One private sector provider	\$90 indexed
Hawaii	none	2019-21	none	Account-based open system	Choice of state and one private sector provider	\$50
Nevada	none	2011	none	Pay at pump	N/A	none
Minnesota	some	2006 & 2012	none	Closed system	N/A	\$75
Colorado	none	2016-17	none	Account-based open system	One private sector provider	\$50
Virginia	2020	none	Under procurement	Account-based closed system	One private sector provider	\$64
ETC phase 1: Delaware, Pennsylvania	none	2018	N/A	N/A	One private sector provider	DE none, PA none
ETC phase 2: adding New Jersey, North Carolina, Virginia	none	2020	N/A	N/A	One private sector provider	NJ none, NC \$130

3.2 Annual flat fees. Near the first decade of the 21st century, states began to augment fuel taxes with annual flat fees on all- electric vehicles (AEVs) to offset the loss of revenue from the fuel tax revenue that AEVs do not pay. The National Conference of State Legislatures (NCSL) reports that, as of November 2020, 28 states had laws requiring a special fee for all-electric vehicles, nearly all of them on an annual basis. Only 14 of these states also assess a slightly lower special fee on plug-in hybrid electric vehicles (PHEVs) . Generally, these fees are added to traditional motor vehicle registration fees. For all-electric vehicles, these special fees range from \$50 to \$225 per year. At least five states structure the additional registration fees to grow over time by tying the fees to the consumer price index or another inflation-related metric.¹⁰

¹⁰ <https://www.ncsl.org/research/energy/new-fees-on-hybrid-and-electric-vehicles.aspx> (accessed July 19, 2021)

Only Utah and Oregon allow vehicle owners of AEVs and PHEVs to avoid the annual flat fee if they opt into paying a mileage-based user fee. In 2017, Oregon allowed AEV owners the option of choosing to pay the 1.8 cents per-mile fee in lieu of an annual flat fee of \$100 by enrolling in OReGO. In 2018, the Utah Legislature followed suit by allowing EV owners the option of paying a 1.5 cent per-mile fee in lieu of an annual flat fee of \$90 which rose to \$120 in 2021.

3.3 Per kilowatt hours fees.

Several RUC concepts have emerged to charge electricity rather than impose an annual flat fee or mileage-based user fee for road use by electric vehicles, to allow supplementation or replacement of traditional gas taxes. This idea has slowly developed because conceptual application of a per-kilowatt hour fee to a state's residents' electric vehicles revealed impracticalities. While a state can easily impose a per-kilowatt hour fee at public charging stations, applying the same fee to *at-home charging*—the place where most EV charging occurs—proved expensive, invasive and ineffectual because of electric rate structure and technical challenges to segregating EV charging from all other residential electric uses. Still, by applying the per-kilowatt hour fee only at public charging stations, the likely principal payers may well be non-resident drivers who need access to charging before heading home across state lines.

One of the objectives for Vermont's road usage charge study is evaluation of the feasibility of using per kWh fee addition to the current price of electricity used for charging electrical vehicles in the public infrastructures. Until 2021, no state had enacted a per kilowatt hour fee on electricity charging for electric vehicle, but the Oklahoma Legislature has just done so.

The Oklahoma law imposes a tax of three cents per kilowatt hour on the electric current used to charge the battery of an all-electric vehicle (AEV) or plug-in hybrid electric vehicle (PHEV) at public charging stations beginning January 1, 2024. The charging station owner shall provide conspicuous notice of the tax on an invoice to electric vehicle owners charging at the station, collect the tax and remit the tax to the state tax commission monthly. This law exempts legacy charging stations in operation prior to November 1, 2021 from tax collection if these stations never had a metering system in place capable of measuring the transfer of electricity to the vehicle or never charged a fee for use of the charging session. Charging stations which begin operations after November 1, 2021 shall use a metering system capable of imposing the tax. The law imposes an administrative penalty for failure to comply.

SECTION 4

4.1 What is Vermont's road usage charge concept?

The state of Vermont is evaluating the feasibility of revising the current transportation revenue system—primarily consisting of excise fuel taxes and diesel taxes paid by owner/operators of internal combustion vehicles—adding an assortment of road usage charges paid by owner/operators of all-electric vehicles (AEVs), plug-in hybrid electric (PHEVs), and possibly

highly fuel-efficient internal combustion vehicles. *Road usage charges* are assessments on a vehicle for usage of the road system.

Under Vermont's road usage charge concept, drivers of all-electric vehicles (AEVs) and plug-in hybrid electric vehicles (PHEVs) registered in Vermont would have the choice of paying either an annual flat fee or a mileage-based user fee. Out-of-state electric vehicles operators recharging at Vermont public charging stations would pay a per kilowatt hour fee on the electricity transferred to the vehicle.

- 4.1.1 **Flat fee option.** A *flat fee* is an assessment for driving on the Vermont road system, not based on vehicle usage but, rather, set at a fixed amount per year. The flat fee would be revenue neutral, meaning the average revenue raised per vehicle would equate to the total fuel tax or diesel tax paid in a year by the average internal combustion engine vehicle (ICEV). The flat fee amount for each vehicle type—EV, PHEV, high mileage ICEV—will depend upon their relative fuel efficiencies, the typical annual miles traveled by the average Vermont resident, and other factors. The expected fee amount per year in Vermont has been estimated in previous studies¹¹ to be about \$120 for an AEV and \$71 for a PHEV, and will be verified as part of this study.
- 4.1.2 **Mileage-based fee (MBUF).** A *mileage-based user fee* is a per-mile fee based on measurement of the actual distance traveled in Vermont by a vehicle registered in Vermont and owned by a Vermont resident. The mileage-based fee would be revenue neutral, meaning the average revenue raised per vehicle would equate to the total fuel tax or diesel tax paid in a year by the average internal combustion engine vehicle (ICEV), adjusted for each electric vehicle type. The expected MBUF rate has been estimated in previous studies to be between 1.3 and 1.5 cents per mile¹¹. The total fees paid for an individual vehicle may be capped at the annual fee amount.
- 4.2 **Per Kilowatt Hour Fee (per kWh fee).** A *per kWh fee* is an assessment on use of the road system based on the amount of electricity charged into an electric vehicle. Under Vermont's RUC concept, non-resident electric vehicles charging at public charging stations in Vermont will pay a per kilowatt hour fee on top of the base charging rate. The expected charging rate as estimated in previous studies is 3.4 cents per kilowatt hour¹¹. Vermont owners of AEVs or PHEVs will pay the fee if using a public charging station unless there is a mechanism identified that can credit Vermont residents. The concept does not include a fee on charging an electric vehicle at a residence.

¹¹ Act 12: Section 28 Report (2013). A Study on Replacing Motor Fuel Tax Revenues Not Collected from Plug-In Electric Vehicles.

https://publicservice.vermont.gov/sites/dps/files/documents/Transportation_LandUse/Goal1/Act12%2C%20sec28%20EV%20fes%20study.pdf

SECTION 5

5.1 Collecting a road usage charge

A road usage charge system collects a fee related to vehicle travel within the applicable jurisdiction. To enable collection of a flat fee or MBUF, the owner/operator vehicle registered in the state creates an account with the authorized government agency. The agency can collect a flat fee by notifying the obligated vehicle owner by invoice and accepting payment, or by including the fee as part of the registration fees. For the MBUF, the agency's mileage charging system calculates the fee based on the reported amount of distance traveled by the vehicle, invoices the vehicle's owner/operator who pays the fee, and the agency accepts payment. For the Per kWh fee, the public charging station meters the amount of kilowatt hours transferred to an AEV or PHEV, and the owner/operator of the public charging station charges a fee per kilowatt hour to the vehicle operator as an individual item on the charging invoice, accepts payment and remits payment to the agency.

5.1.1 Calculating distance traveled for an MBUF. Researchers in the states have explored a number of ways to determine a vehicle's distance traveled, primarily relying on reporting of data generated by the vehicle's computer systems. The various reporting methods range from drivers' manually reporting odometer readings to automatic reporting from devices installed within vehicles.

5.1.1.1 Manual reporting. There are several ways to manually report odometer readings to calculate the MBUF. California and Washington have pilot tested manual odometer reporting as the basis of a road usage charge. Most recently and extensively, the Hawaii Road Usage Charge (HiRUC) demonstration used odometer readings compiled during periodic vehicle inspections to produce customized driving reports comparing each vehicle's fuel taxes paid with a MBUF. The demonstration, launched in October 2019, aims to reach over half a million households. To determine fuel taxes paid, HiRUC applied the state fuel tax rate to an estimate of a vehicle's fuel consumption. HiRUC estimated fuel consumption by dividing the vehicle's reported miles traveled by the vehicle's EPA combined city/highway fuel economy rating. This estimation method for calculating fuel consumption is generally consistent but not necessarily accurate.

5.1.1.2 Automatic reporting. For the most common method of automated reporting, a participating vehicle owner or operator installs a plug-in reporting device that connects to the vehicle's on-board diagnostic system (OBD). Essential to automated reporting, the OBD system accurately records a vehicle's distance-traveled and fuel consumption. The reporting device accesses this data from a vehicle's OBD system and wirelessly reports it to an account manager for purposes of generating a billing statement.

Numerous U.S. states have fielded automated mileage reporting for MBUF, including live operational programs in Oregon and Utah and pilot tests in Washington, California, Colorado, Minnesota and Hawaii. Many residents of eastern states experienced automated reporting by participating in pilot tests undertaken by the Eastern Transportation Coalition.

For the nation's first operational MBUF program, the state of Oregon certified the use of OBD-accessible, plug-in, reporting devices in 2015 for collecting an actual per mile fee, with a fuel tax credit, from participating drivers. These certified technologies accessed the necessary data for reporting miles driven and fuel consumption through the OBD II system. The state of Utah launched a similar operational MBUF system in January 2020.

Methods		Oregon	California	Washington	Utah	Hawaii	Colorado	Minnesota	ETC
No reporting	Time Permit ¹²	2019 on	2016-17		2020 on				
No reporting	Mileage Permit ¹³		2016-17	2018-19					
Odometer	Reporting by hand					2019-21		2006	
Odometer	Reporting via app						2016-17		
Odometer	Photo image verification		2016-17	2018-19	2020 on	2020-21			
Automated	OBD-II plug-in device	2015 on	2016-17	2018-19	2020 on	2020-21	2016-17		2018-19
Automated	Native automaker telematics ¹⁴		2016-17		2020 on			2020-21	
Automated	Smartphone app		2016-17	2018-19				2012	2018-19
Automated	Pay at the pump	2006-07	Testing In 2021						

5.1.2 Processing of automated vehicle data reporting

The account manager for an MBUF system can either be the authorized state agency or a private sector vendor, or both. For the Utah operational MBUF program, the state contracts with private sector vendors who undertake billing, tax processing and account management services on behalf of the state.

The Oregon operational MBUF program provides both a state account management option and a private sector vendor account management option with multiple vendors to foster competition under an open system. The Utah operational MBUF program provides only a single private sector account manager, but Utah DOT intends to open up their program to multiple providers once the program reaches a level of maturity that can support more vendors. The emerging Virginia operational program currently seeks only one vendor operating under a closed proprietary system.

MBUF account managers process distance-traveled and fuel consumption data reported remotely from participating vehicles. Based on these data, the account manager calculates an MBUF by multiplying a statutory rate by the reported vehicles miles traveled with a credit for

¹² Purchase a specific period of time. Also known as added registration fee.

¹³ Purchase a specific number of miles.

¹⁴ Factory-installed within vehicle

gasoline tax paid. The account manager calculates the fuel tax credit by multiplying the fuel tax rate by the number of gallons of fuel consumed during the same reporting period. After determination of the net amount owed, the account manager processes an invoice, bills the vehicle owner or operator and collects the tax for deposit into the state highway fund.

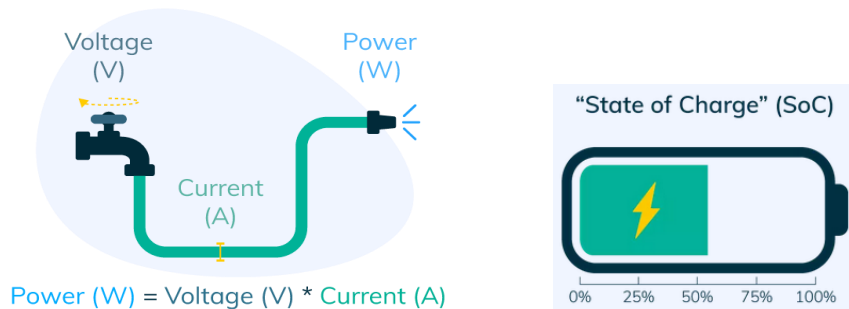
Section 6

Collecting a Per-Kilowatt Hour Fee

Electric vehicle drivers have the option of paying for electricity delivered to their vehicles and therefore the public charging networks owners with point-of-sale systems have the ability to price the service on a per kilowatt-hour (kWh) basis.

6.1 Electrical Charging Terms

Charging an electric vehicle is similar to water flowing through a pipe.



- **Voltage (Volts)** refers to the tension, or potential of energy. Using the above analogy, “water pressure” is equivalent to “voltage.” The higher the pressure, the more water can push through. The same applies for voltage; higher voltage means each bit of electricity can provide more power.
- **Current (Amps)** refer to the flow of electrons through a conductor. Using the water pipe analogy, this describes the volume of water flowing. The wider the pipe, the more water can flow.
- **Power (Kilowatt or kW)** describe the rate at which energy is transferred. Using the water pipe analogy, we find that rate by multiplying the voltage (the water pipe pressure) by the amps (the flow rate or water).
- **Energy (Kilowatt-hours or kWh)** is the amount of energy transferred over one hour. Using the water pipe analogy, it refers to how much water or energy flows out of the pipe over one hour. A bigger battery pack with a higher number of kWh will hold more electricity, just as a bigger bucket will hold more gallons of water.

- **State of Charge (SOC)** describes how full your battery is, measured as a percentage. Think of it like a fuel gauge.

6.2 Major components of electric vehicle charging infrastructure

Public electric vehicle charging infrastructure includes the following major components:

- **Power Sources** (existing power grid /utility network or on-site power generation, when the utility power source is not available, using solar panels or wind turbines) – these provide the energy required for charging stations.
- **Electrical Infrastructure Point of Interconnection (PoC)** - point where the power source is electrically connected to the charging station; at this location the utility has an electricity meter for billing the customer (i.e., charging station owner).
- **Energy Storage System** (optional; typical for on-site generation option) – this is used to store energy produced by solar panels or wind turbine during the day and use later when drivers are charging their vehicles.
- **Electric Vehicles Charging Station Parking Stalls** - this is the location where the EV drivers are paying for charging using different technologies (RFID card, credit cards, contactless payment using cell phone, etc.).

6.3 Vehicle Refueling – Understand the Basics



Gasoline Vehicle	Function	Electric Vehicle
Gasoline tank	Stores the energy to run the vehicle	Battery
Gasoline pump	Replaces the energy to run the vehicle	Charger
Gasoline engine	Provides the force to move the vehicle	Electric motor
Carburetor	Controls acceleration and speed	Electronic controller
Alternator	Provides power to accessories	DC/DC converter
	Converts DC to AC to power AC motor	DC/AC converter
Smog controls	Lowens the toxicity of exhaust gasses	

6.4 Public Charging Station Pricing

Pricing can be established by the *site-host* owner¹³ or the electric vehicle charging *network* owner. There are three approaches for calculating the price of charging (\$/kWh):

- **No fee** - Charging is offered for free to customers as an amenity. Value is derived from alternative sources such as increased sales or corporate branding.
- **Nominal Fee to Cover Costs** (set as a price per kilowatt-hour of electricity delivered) - Fees are set high enough to recoup charging station costs and insulate the owner-operator from spikes in costs from increased utilization (e.g., demand charges/fees from utilities).
 - Cost of electricity (\$/kWh); the charging rates for electricity are based on the location/geographic area, time of use (TOU), length of use (slow or fast charging) and power level, which factor in the price of the commercial electricity usage. State legislation and regulations determine the maximum a company can charge based on the source of the energy provided.
 - Charging station installation, maintenance, and operational costs.
 - New fix price of road usage (\$/kWh)
 - Other taxes and fees (credit card transaction fees, etc.)
- **Profit Center:** The fee for charging is designed to turn a profit from the sale of charging services. Fees are typically set as a price per kilowatt-hour delivered inclusive of the elements mentioned in the “nominal fee” approach plus profit.

6.5 Public charging pricing models

Currently, there are three primary public charging pricing models:

- 1) Pay as you go (preferred)
- 2) Monthly subscription (charging requires a membership subscription)
- 3) Free (charging is offered as an amenity for customers or to just promote green driving).

The charging station network providers typically offer a combination of the first two, including a lower rate for the users that choose the subscription method (i.e., incentivize frequent user of the charging station).

The market for the electric vehicle charging infrastructure *site hosts* follows *two primary business models*¹⁴:

- Owner-operator of charging station infrastructure
- Third-party owned and operated charging station infrastructure

In the “owner-operator” business model, the site host owns and operates the charging station infrastructure. The owner-operator has complete control over the kWh price to charge electric vehicles and is also responsible for working with their electric utility company, obtaining permits,

coordinating station maintenance, and covering any operating costs associated with the charging infrastructure.

In the “third-party owned and operated” business model, the site host leases space to a third-party (e.g., Tesla, Volta, etc.) who then installs and operates the charging infrastructure. In this case, the site host collects rent from the third party but otherwise typically has limited or no control over the kWh price for customers to charge their vehicles and is not responsible for station maintenance, utility coordination, or other operational costs.

For the “owner-operator” business model, the pricing management and customer payment (collection of kWh fees) requires a charging station management software that is typically purchased from a charging service provider such as Blink, ChargePoint, or Electrify America. This software also offers network access, allows owner-operators to track charging station usage, and makes the station locatable via mobile app-based software.

In some regions of the country, regulations and requirements make it difficult for companies that are not utilities to sell electricity for vehicle charging per kWh. In other states (such as Iowa), providing charging service does not necessarily make a business a public utility. The study will verify and document whether this situation exists in Vermont. This is a significant matter because the public utilities are subject to state oversight on all aspects of their business, including the setting of prices. Also, the business owners of charging services may include additional fees, and even sell power they generated on site such as with solar panels or wind turbines. This gives freedom and flexibility to price charging services and meet the needs of various types of customers.

Electricity used by commercial type chargers (AC Level 2 Charger and Direct Current Fast Charger) is usually metered using commercial and industrial electricity rates, which in most cases incorporate a per-peak-kW demand charge plus a volumetric per-kWh energy tariff. The demand charge rises proportionally for additional chargers since it depends only on maximum demand.

Commercial tariffs typically offer lower volumetric charges (\$/kWh), but also requires the demand charges - \$ /peak kW (set by the highest level of demand over any 15-minute period over the course of one month). Demand charges reflect the projected cost to the utility of providing the generation and distribution infrastructure required to meet peak demand on both a system level and a local distribution system level.

The demand charges are applied widely by the Vermont utilities to all large (higher usage) customers. The Burlington Electric Department (BED) is an owner-operator of several public charging stations. Usage of charging stations owned by customers of BED will be under the tariff normally applicable at the service location.

¹³ Site host is the entity that owns the property where a charging site is located.

¹⁴ Charles Satterfield and Nick Negro, Atlas Public Policy Washington DC, Public Charging Business Models for Retail Site Hosts

Section 7

Primary Issues Impeding Adoption of Road Usage Charging

7.1 The political and practical issues of mileage-based user fees

Generally, the states have solved the early technical and system issues identified for the per-mile fee. Five issues persist to impede widespread adoption.

1. **Protection of privacy and security of data.** Many drivers do not want to surrender their driving data to anyone, especially the government. They do not believe a per-mile fee system can protect their data.
2. **Equity by geography.** Rural and long-distance drivers often object to the per-mile fee for fear that the distance-based fee will unfairly burden them relative to urban drivers.
3. **Equity by vehicle type.** Advocates for zero-emission vehicles, such as all-electric vehicles, have expressed concern application of the per-mile fee to them will hamper EV adoption.
4. **Equity by income level.** Advocates for low-income families have expressed concern that the per-mile fee will unfairly burden those households.
5. **Cost of administration.** Spending watchdogs fear that the cost of operating a per-mile fee system will be excessive, certainly when compared to the extraordinarily inexpensive operational cost of the excise fuel tax.
6. **Complexity.** Devising a new fee system that asks too much of the payer leads to complaints about complexity.

These issues have solutions, or at least solutions that are under development, but the proposed application of the solutions have yet to occur in a meaningful way that changes opinions. See Appendix A for further discussion of the issues the advisory committee will undertake.

7.2 Perspectives on annual flat fees

Although annual flat fees have easy application, the chief impediment to their ubiquitous application lies in the fact that they do not relate specifically to use of the road system and thus are unfairly applied without consideration of context. Many drivers regard annual flat fees as unfair because those who drive fewer miles subsidize those who drive many miles. Who can defend a tax policy that makes grandma—who only drives to the grocery store, to visit her grandchildren and to church on Sunday—pay the same fee amount as a travelling salesman? Accordingly, for political viability, annual flat fees must remain low. To provide adequate revenue for the road system, annual flat fees should be high. This is the paradox of annual flat fees as a road funding solution.

7.3 The challenge of collecting a fee on vehicle electricity charging

As described above, collecting a fee on the charging of all electric vehicles has nearly impossible impediments. Without a separate, dedicated utility metering device, or accurate sub-meter, for electric vehicle charging in homes and workplaces, the system could not identify and segregate vehicle electrical charging from other electricity uses. Requiring placement of electric vehicle metering devices for charging in homes and workplaces would prove inordinately expensive, an expense not every household can afford and raising questions of equity. Imposing home metering requirements for electric vehicles raises the question of the ability to enforce the fee because of the ease of evasion. There are simply too many places in which to plug into an electrical outlet to avoid the meter and hence the fee. Furthermore, a fee on home and workplace electric vehicle charging would dampen the attractiveness of electric vehicle use by eliminating the advantage of a lower EV-specific electricity rate, and especially if the PUC imposes time-of-use limitations on when to charge electric vehicles to manage increased stress on the electricity grid.

The only place that has potential viability for placing a per-kilowatt hour fee is at public charging stations, a not so universal, and thus somewhat unsatisfactory, application. Yet issues emerge here too, such as the capability of utilities to develop billing system upgrades and the possibility of stranded costs that utilities cannot recover. Although apparently many, but not all, public charging stations will have dedicated utility meters.¹⁵

Section 8

Projections of the future of alternative funding in the United States

8.1 Context. The states have sought alternatives to the current funding mechanisms for the road system for two decades. VTrans presents the most common and, indeed, the most likely alternatives in its road usage charge concept. Each of the three possibilities—mileage-based user fees, annual flat fees and the per-kilowatt hour fee—have strengths and weaknesses, yet all have viability as part of a new road funding system.

8.2 Mileage-based user fee development.

Mileage-based user fees have proven technical viability through numerous pilot programs and two operational programs. These efforts have identified the ultimate mileage collection mechanisms. Hawaii's pilot presents a viable manual approach to collection of mileage data for states with an annual vehicle inspection, such as Vermont. Utah's operational program presents a way for a per-mile system to access native in-vehicle telematics, already installed in most new vehicles at the factory. In-vehicle telematics has mileage metering capabilities which

¹⁵ PUC Docket #19-3009-IMV. Supplemental Electric Vehicle Report per Section 35 of Act 59 (H.529) of the 2019-2020 Vermont Legislative Session, p 16. Available from: https://puc.vermont.gov/sites/psbnew/files/doc_library/EV-Supplemental-Report.pdf. [Accessed on August 3, 2021].

dramatically reduces the cost of mileage reporting, but so far there is no formal arrangement with the automakers, except for Tesla, to allow access to this technology.

It is reasonable to expect that the automakers will allow access to in-vehicle telematics for automated reporting. Either the federal government, the state of California, or a consortium of states will mandate government access to and standards for in-vehicle telematics. When that happens, per-mile fee systems will become easy and much less costly to operate, and political objections against enactment may fade away.

Even if MBUF becomes widely accepted and deployed across the country, it will likely not replace payment of the fuel tax for all vehicles. Vehicles below the mid-point of fuel-efficiency may continue to pay the fuel tax rather than the MBUF because they generate, per car, an adequate level of revenue. Not including them in MBUF will solve the ornery question of whether to grant them a rebate of fuel tax paid above the MBUF paid.

8.3 Annual flat fees

Already common to many states, the annual flat fees will retain their place in road funding, yet in most cases only as a choice available to vehicle operators that, for various reasons, may not prefer mileage-based user fees. Administration of the annual flat fee has the desired simplicity and so will survive as either at a low amount or as an alternative to mileage-based user fees. As that alternative, however, the annual flat fee must be set at an amount that does not undermine participation in a mileage based user fee option. Those whose annual driving cost per-mile is less than the flat fee rate will choose to pay per mile. Those whose annual driving costs are higher than the flat fee rate will choose the flat fee. For example, if Vermont had a \$150 annual flat fee and a 1.5 cent per-mile fee, the break-even point is 10,000 miles per year. Those driving 12,000 miles per year would pay the flat fee to avoid paying a higher per-mile fee that results in \$180 per year. The outcome is that the state loses revenue from high mileage drivers, which utilize and benefit most from the highway system.

8.4 Per-kilowatt hour fees will become more common

Ultimately, placing a fee on vehicle electricity charging at public charging stations has viability albeit not uniformity. Placing such a fee with the primary objective of capturing revenue from out-of-state drivers has special applicability and should become common among the states. Still, as no state has deployed this system, the capital costs of collecting the per kWh fee, and other challenges, have to be documented and could impede application.

APPENDIX A

Road Usage Charge Administrative, System and Policy Issues

6.1 Context. VTrans intends for the advisory committee to advise the agency on the feasibility of going forward with the Vermont Road Usage Charge Concept as either an operational program or a pilot demonstration. During the process, VTrans expects the advisory committee to recommend decisions on administration and policy that, along with the design of the RUC concept, make up the necessary elements of legislation for either the operational program or pilot demonstration.

6.2 Essential administrative and policy questions. Many of the policies contained in the Vermont Road Usage Charge Concept (see section 4) make up the essential elements of legislation for either an operational program or a pilot demonstration. Not all administrative, systems or policy questions need resolution in legislation as the authorized agency makes certain decisions. The remaining essential administrative, system and policy questions are as follows.

- **Administration: Identifying the authorized agency**

Road usage charge administration requires determination of which agencies will fulfill the functions of a road charge program—processing, collection, account management, compliance, operations, oversight—including agency collaboration and accountability.

The high-level operational functions of a road charge system include the following:

1. Road charge identification, processing and collection
2. Customer service and account management
3. Compliance, enforcement, and audit
4. Maintenance and operation of the vehicle registry
5. Oversight of the system activities, including monitoring and reporting

The first two operational functions—road charge identification, processing, collection, customer service and account management—can be delivered by either a government entity or a contracted private sector company that specializes in these services. The latter three operational functions—compliance/enforcement/audit, vehicle registry, and oversight—remain largely or entirely within the purview of an authorized state agency.

Determining an administrative framework for road usage charge requires high-level choices regarding which agency or agencies will fulfill each of the functions of a road charge system, how they will collaborate, and how they will be accountable to the public.

For Oregon's and Utah's operational per-mile fee programs, the state legislatures chose the Departments of Transportation as the authorized agencies. For Virginia, the state legislature chose the Department of Motor Vehicles as the authorized agency.

For Vermont's road usage charge system, candidates for the authorized agency include the Agency of Transportation (Policy, Planning and Intermodal Development Division), the Department of Motor Vehicles, and the Department of Taxes.

- **How collection of MBUF occurs: state management, private sector account management, or a choice**

Although often couched in terms of either government or private sector provision, road charge administration can also be provided in various combinations. Though complex, scrutinizing MBUF administration presents several possibilities.

1. **Government agency-only.** An authorized government agency provides all account management services: customer service, account management, road charge identification, processing and collection
2. **Private sector-only**
 - Single service provider: closed or open system
 - Multiple service providers in an open market that allows vehicle operators to choose a provider based on different options and additional services offered.
3. **Combinations**
 - Government agency and open market for multiple private sector providers
 - Government agency and single private-sector provider: closed or open system

The delivery method affects timetable, complexity, cost and risks for implementation and operations of a per-mile fee system.

For Oregon's operational per-mile fee system, the state chose a combination of government account management and private sector account management in a competitive open market. For Utah's operational per-mile fee system, the state chose a single private sector entity to provide account management as an introductory measure with intentions for additional private sector providers once the program grows. Both Oregon and Utah's programs use a nonproprietary open system to allow competition among providers. For Virginia's mileage-based fee program, the state seeks a single private sector entity to implement a closed system. Open systems have greater flexibility and facilitate competition. A state choosing a closed system must make a wise initial choice of provider as it is difficult, if not impossible, to undo a proprietary system.

- **Vehicle eligibility: should gasoline hybrids and other highly fuel efficient vehicles pay an MBUF**

Gasoline hybrid vehicles and other high mileage vehicles pay less fuel taxes per mile than the average internal combustion engine vehicle. Including them in a road usage charge program

may help create a more sustainable future for Vermont's road revenues. Even so, applying a mileage-based fee program to gasoline powered vehicles raises more complex questions, like whether to create a flat fee alternative for gasoline vehicles or provide for an offset of fuel taxes paid against the per-mile fee.

Oregon's operational per-mile fee program includes not only AEVs and PHEVs but gasoline hybrid vehicles and high mileage vehicles rated at 40 MPG and above. Oregon's MBUF is 1.8 cents per mile and the alternative annual flat fee for AEVs is \$110 and for vehicles rated at 40 MPG and higher \$33.

Utah's road usage charge program includes gasoline hybrid vehicles, as well as AEVs and PHEVs, each paying an annual flat fee or an MBUF. Utah's MBUF is 1.5 cents per mile and the alternative annual flat fee for AEVs is \$120, PHEVs \$52 and gasoline hybrids \$20.

- **Identify eligible miles: charge only Vermont miles or all miles**

Should Vermont's MBUF program charge only for miles traveled in Vermont, then a portion of the state's drivers may want a location-aware mileage automatic reporting option as an alternative to an odometer reading or a non-location aware automatic mileage reporting option. Charging all miles driven by Vermont residents may not seem fair to many but it is essentially the same as what happens now when a Vermont driver fuels up in the state, paying the gas tax for a cross-border trip outside the state.

- **Rate recommendations for flat fee, MBUF and per kWh fee**

The selection of rates represents a core function performed best when supported by accurate information and informed by the full range of approaches to rate setting possible under a road usage charge system. Relevant data and expert analysis can inform the legislature's rate setting process, especially in complex situations. Simple to understand and easy to implement, a flat rate for all vehicles provides a straightforward basis for projecting revenue. However, other policy priorities and perspectives may drive consideration of other factors in setting per-mile rates. The possibility of such factors depends on the system design. Among the factors for consideration include revenue neutrality and fair share, equitability, revenue generation potential and financial sustainability, do no harm to electric vehicle take-up, vehicle weight, emissions profile, vehicle owner income level, cost responsibility relative to heavy vehicles and complexity.

- **Automatic rate adjustments**

There are several mechanisms for increasing the road usage charge rates without legislative or public utility commission action. One applies an inflation escalator based on an index. Common indices for inflation escalators include the consumer price index and producer price index, the latter of which features specific sub-indices for highway and street construction costs. The U.S. Bureau of Labor Statistics maintains and publishes these indices regularly.

A second mechanism links the rates to increases made to the state's gas tax. When the state legislature increases the gas tax, the road usage charge rates increase as well. For example, Oregon has tied its MBUF rate to five percent of the state's excise fuel tax rate.

- **Penalties for failure to pay, beyond collections process and interest, such as late fee, hold on vehicle reregistration and criminal penalty for tampering**

The authorized agency can easily manage failure to pay the flat fee or MBUF through the state collections process and adding interest to the amount owed. Other enforcement methods—a late fee, a hold on vehicle reregistration and criminal penalties for fraud and tampering—will require inclusion in state law. The authorized agency may seek stronger and more effective enforcement protocols later once the nature of tax evaders and their evasion practices become known.

6.3 Discretionary policy questions. Other administrative and policy questions are discretionary. The advisory committee may make recommendations about them or leave the question open for legislative determination.

- **Protection of privacy and security of reported data**

Privacy emerged as a central issue for mileage-based fees 20 years ago and has sustained its hold on the public's attention until today notwithstanding a thorough surrender of privacy in social media, on-line apps and other digital business practices that have emerged since then. The intensity of the issue can soften after deployment of certain solutions. Furthermore, concerns about protection of personal data appears to vary among age groups.

In the context of location-aware automatic mileage reporting, giving the driver an alternative choice of a non-location-aware mileage reporting method, whether automatic or odometer reporting, can lessen the intensity of the issue of the most concerned. Offering a choice of account manager—whether the government or among several private sector providers—can also reduce concerns over privacy and data security.

Providing technological protections of privacy and data security—such as data encryption, thick-client devices, data masking and regular data purging—can actually protect privacy and security even though many people may not trust the offered commitment.

Legal statutory protections offer a stronger way to protect the privacy and security of personal information and data for a per-mile fee program. The law can offer prohibitions for transfer of personal information without written consent, along with penalties for violators and establishment of personal rights for per-mile fee payers. The state of Washington developed a comprehensive Model Privacy Policy for the per-mile fee in 2019 based on elements of the California Consumer Privacy Act of 2018, the European Union's General Data Protection Regulation and the Oregon road usage charge privacy protection provisions.

- **Equity Perspectives**

A single flat rate for a per-mile fee imposed on vehicle travel of all drivers notwithstanding individual circumstances raises the issue of equity. Equity is largely a matter of perspective. Some regard a single flat rate on all miles traveled as equitable compared to the excise fuel tax for which no policy basis exists for some people paying more or less per mile than other drivers simply because they driver different vehicles.

Equity by geography. One of the most visceral objections to the per-mile fee comes from the nation’s rural residents who believe the policy targets them and their lifestyle, assessing more taxes on those who “have to drive longer distances” to access jobs and essential services. This concern seems less likely in Vermont, given shorter driving distances to towns and cities relative to other states. Even so, rural residents who do drive longer distances will, on average, benefit from a road charge over a gas tax, given the preponderance of working vehicles in rural areas that consume more fuel per mile driven than average, such as large pickups and utility vehicles.

A policy approach that may address rural residents’ objection would apply the per-mile fee only to high mileage vehicles, leaving the remaining lower mileage vehicles paying the gas tax. Vermont’s Road Usage Charge Concept may apply this strategy.

Equity by vehicle type. Given the growing interest in reducing greenhouse gas and other vehicle emissions, electric vehicle advocates have expressed concerns that, relative to the fuel tax, road usage charges could hamper sales of EVs. Although fuel taxes were intended as a road tax rather than an environmental disincentive, adding a fee to EV driving will add a slight burden to EV use. The additional cost, however will be manageable for most—less than \$200 per year for driving 12,500 miles—relative to savings from avoiding the cost of gasoline and much lower maintenance costs. This manageable burden, made easy to pay, should not hamper EV sales and use. The state of Vermont must decide whether providing incentives for EV purchase—such as tax credits—will be sufficient to offset the cost of a RUC in the minds of potential EV purchasers.

Equity by income level. Advocates for low-income drivers show concern that flat rate road usage charges will disadvantage them relative to more affluent drivers. While the additional burden will be manageable—about \$150 per year for driving 10,000 miles—every additional cost challenges those at the lowest income level. The state may offer a rebate of a portion of the additional cost to low-income drivers through some tax adjustment mechanism. The impact of such a rebate program to the state budget is likely to be miniscule as those at the lowest income level will likely purchase only used EVs, for which demand should be small—installation of fast charging units into homes is expensive—and availability minimal.

APPENDIX B

Per Kilowatt Hour Administrative, System and Policy Issues

6.1 Context. VTrans intends for the advisory committee to advise the agency on the feasibility of going forward with the Vermont Road Usage Charge Concept as either an operational program or a pilot demonstration. During the process, VTrans expects the advisory committee to recommend decisions on policy that, along with the design of the RUC Concept, make up the necessary elements of legislation for either the operational program or pilot demonstration.

6.2 Essential administrative and policy questions. Many of the policies contained in the Vermont Road Usage Charge Concept (see section 4) make up the essential elements of legislation for either an operational program or a pilot demonstration. The essential policy questions are as follows.

- **What is the definition of public charging station for purposes of applying the per kWh fee?**

Some public charging stations require payment for the electricity charge while others offer the charge without fee. It may be challenging for “free” public charging stations—such as those at hotels, workplaces and grocery stores—to collect the per kWh fee because they may not have the point-of-sale systems in place to accept payment from vehicle owners. The requirement to collect a per kWh fee may require adding an otherwise unnecessary point-of-sale system. Furthermore, not every public charging station will have the similar metering systems upon which the per kWh fee will be based. Those stations owned and operated by local utilities may have common availability and the necessary systems in place.

- **Who pays the per kWh fee?**

There are two options for who pays the per kWh fee. The mandate for a per kWh hour fee could apply the fee to the vehicle operator when charging electricity at a public charging station and collected along with the price of the electricity charge. Alternatively, the mandate could apply to the operator of the public charging station for all electricity charged at the station. In the first case, the public charging station operator would have the obligation to collect the fee and forward it to the authorized agency. In the second case, the public charging station operator would have the impetus to include the cost of the per kWh fee in the price of the electricity charge to the vehicle owner. In either case, absent any requirement, the station operator may or may not transparently display the cost of the fee to the vehicle operator on their receipt or statement of charges.

- **Rate setting**

If the per kWh hour fee is not part of a tariff, the state legislature may set the rate. Setting the rate pay depend on factors similar to those for MBUF, such as revenue neutrality and fair share, equitability, revenue generation potential and financial sustainability, do not harm to electric

vehicle take-up, vehicle weight, vehicle owner income level, cost responsibility relative to heavy vehicles and complexity.

- **Identifying the agency responsible for receiving per kWh fee revenues**

Should collection of the per kWh fee occur by obligating the owner/operator of the public charging station to collect and remit the fee, this arrangement would be similar to collection of the excise fuel tax. In this case, the Vermont Public Utility Commission expects the Department of Motor Vehicles would receive the fee revenues.¹⁶

- **Enforcement of per kWh fee**

Enforcement of the per kWh fee may happen in a manner similar to the excise fuel tax. An important assignment is which agency should have authority for enforcement. The Vermont Public Utility Commission believes enforcement authority for the per kWh fee should rest with the Department of Motor Vehicles and the Attorney General.¹⁷

¹⁶ PUC Docket #19-3009-IMV. Supplemental Electric Vehicle Report per Section 35 of Act 59 (H.529) of the 2019-2020 Vermont Legislative Session, p 18. Available from: https://puc.vermont.gov/sites/psbnew/files/doc_library/EV-Supplemental-Report.pdf. [Accessed on August 3, 2021].

¹⁷ Ibid, p 19.